

**Testimony of
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Assistant to the President
for
Science and Technology**

before the

**Subcommittee on Science, Technology and Space
Committee on Commerce, Science, and Transportation
U.S. Senate**

March 1, 2000

Mr. Chairman and Members of the Subcommittee, thank you for this opportunity to testify about the important research and development investments proposed by S.2046, the Next Generation Internet (NGI) 2000 Act. These investments are a vital portion of the Administration's information technology (IT) research portfolio that strengthens and expands the important Federal networking research authorized, thanks to your sponsorship, by the NGI Act of 1998.

The Administration has been very encouraged by the active bipartisan support which both chambers of Congress have provided for efforts to strengthen our nation's investments in information technology research and development and we look forward to continued support for the exciting new work proposed in the administration's proposed FY2001 budget. Here in the Senate, your leadership, Mr. Chairman and that of the members of the Subcommittee, has been especially instrumental in helping your colleagues recognize that the advances in information technology which are so vital to the overall success of our nation's scientific and technical expertise, as well as to its economic prosperity, require a foundation of wise, sustained Federal research investments.

We are enjoying a time of unprecedented possibilities and prosperity, built on advances in science and technology enabled by Federal support for R&D. Creative businesses have translated the results of Federally funded advanced research into innovative products and services enjoyed today. This innovation has improved our quality of life, strengthened our national security, and unleashed an extraordinary era of post-war economic growth. Many of America's industries are now the most competitive and technologically advanced in the world. The Federal government has had an important role in sharpening our high-tech edge. Through policies such as investing in education, encouraging private-public partnerships, and limiting regulation of the Internet, the Administration has enhanced opportunities for scientific discovery

and allowed innovation to flourish. Most importantly, as the President noted in his February 24 remarks to the Granoff Forum at the University of Pennsylvania, this Administration has worked to accelerate R&D at every level – pushing for an extension of the Research and Experimentation tax credit and increasing our national science and technology budget every single year over the last seven years.

The Nation Benefits from Federal IT R&D Investments

The case for sustained and adequate Federal investments in R&D is made most dramatically in the information technology sector. The President's Information Technology Advisory Committee (PITAC) notes that "that the technical advances that led to today's information tools, such as electronic computers and the Internet, began with Federal Government support of research in partnership with industry and universities. These innovations depended on patient investment in fundamental and applied research." The PITAC emphasizes, however, that continued Federal investment is essential to maintain this momentum. In their February 1999 report to the President, *Information Technology Research: Investing in Our Future*, the PITAC called for doubling Federal IT R&D investments over five years and expanding the existing coordinated interagency research programs to achieve a more balanced research portfolio. The Administration responded to the PITAC's proposals in FY 2000 with a major increase in IT research funding through the Information Technology for the Twenty-First Century initiative. We continue to build on the PITAC's recommendations with the programs recommended in the President's FY 2001 budget.

Although the dividends that our nation has reaped from past Federal investments in computing and communications research are well recorded, they are worth repeating. Federal support of IT R&D, leveraged by industry and academia, has led to technical advances which today are transforming our society and driving economic growth and the creation of new wealth. New computing, networking, and communications tools allow Americans to shop, do homework, and get health care advice online, and enable businesses of all sizes to join the international economy. Since 1995, more than a third of all U.S. economic growth has resulted from IT enterprises, and during the past decade, more than 40 percent of U.S. investment in new equipment has been in computing devices and information appliances. The IT sector is growing at double the rate of the overall economy and will soon account for 10% of the economy. Companies doing business on the Internet had an average market capitalization of \$18 billion in 1999, more than 30 times the average market cap for all companies listed on the NASDAQ.

As computers, high-speed communication systems, and computer software become more powerful and more useful, IT penetrates deeper into our home, work, and education environments. Nearly half of all American households now use the Internet, with more than 700 new households being connected every hour. More than half of U.S. classrooms are connected to the Internet today, compared to less than three percent in 1993. In 1993, only a few

technical organizations knew what an address like <http://www.senate.gov> meant, and today, there are nearly 13 million registered addresses. Today, more than 13 million Americans hold IT-related jobs, which are being added six times faster than the rate of overall job growth. Over 800,000 jobs were created by IT companies in the past year alone.

This astonishing progress has been built on a foundation of Federal agency investments in research conducted in universities, Federal research facilities, and partnerships with private firms. The Federal HPCC Program met its 1996 goals of demonstrating computers that perform a trillion operations per second and communication networks that transmit a billion bits per second. The Next Generation Internet initiative has exceeded its year 2000 goals by connecting more than 170 universities and other research centers at rates 100 times faster than those available when the project began and more than 15 institutions at rates 1,000 times faster. Such ultra-high-speed networks provide desktop-to-desktop connections nearly 20 million times faster than typical Internet connections to home computers.

The President's FY2001 IT R&D Budget

The President's FY 2001 budget reports all aspects of IT research – the base HPCC programs (including Next Generation Internet) and the new activities established by last year's Information Technology for the Twenty-First Century initiative -- in a single integrated IT R&D program. The President is requesting \$2.315 billion for IT R&D, \$594 million more than last year's appropriations and a billion dollars more than the FY 1999 appropriation. The largest increases above FY 2000 funding are proposed for the National Science Foundation, which is leading the interagency effort (+\$223M), the Department of Energy (+\$150M), the Department of Defense (+\$115M), the National Aeronautics and Space Administration (+\$56M), and the Department of Health and Human Services (+\$42M).

IT R&D Budget Summary

	FY 2000 (\$M)	FY 2001 (\$M)	Percent Increase
Department of Commerce	\$ 36	\$ 44	22%
Department of Defense	\$ 282	\$ 397	41%
Department of Energy	\$ 517	\$ 667	29%
Environmental Protection Agency	\$ 4	\$ 4	0%
Health and Human Services	\$ 191	\$ 233	22%
National Aeronautics and Space Administration	\$ 174	\$ 230	32%
National Science Foundation	\$ 517	\$ 740	43%
TOTAL	\$1,721	\$2,315	35%

Agencies will continue to support the basic goals established in last year's initiative, focusing on fundamental research in software; development of information systems that ensure privacy and security of data and allow people to get information they want, when they want it, in forms that are easy to use; support for continued advances in high-speed computing and communications, including work needed to ensure that raw speed translates into usable speed; and work to understand the social, economic, and other impacts of IT with emphasis on ensuring that all

Americans will benefit from these technologies. The U.S. research community responded to last year's call for research ideas with a flood of creative new proposals, a demand which far exceeded the supply of new funding in agencies such as NSF and DOD. As a result, with FY 2000 funding, NSF will start 25 small research centers and five larger centers.

As in previous years, the proposed IT research portfolio is based on coordinated, interagency investments which leverage expertise across agencies to give the best returns on those investments, both financial and technical. FY 2001 IT R&D priority areas include:

Teams to Exploit Advances in Computing: Expanded activities by NSF, DOE, NIH, NASA, and NOAA will support new partnerships where information scientists, mathematicians, and experts in areas such as medical research, weather modeling, and astronomy can work together to build tools for solving the Nation's most pressing information problems. These partnerships will advance information science and lead to research breakthroughs in application areas.

Infrastructure for Advanced Computational Modeling and Simulation: In FY 2001, NSF plans to establish a second terascale (five trillion operations per second) computing facility to support the civilian research community.

Storing, Managing, and Preserving Data: Current networks and data storage systems are straining to support vast amounts of information. NASA's new earth observing satellite will generate data equivalent to three times the information in the Library of Congress every year. Research will include developing devices capable of storing a years output of such systems in devices the size of PC hard disks; searching data in a variety of formats including pictures, video, audio; and developing improved ways of filtering information, data mining, and tracking lineage and quality of information.

Managing and Ensuring the Security and Privacy of Information: Research will focus on systems that can ensure privacy and security without compromising speed and ease of use. DOE, for example, recently developed a prototype chip that can encrypt 6.7 billion bits per second. Work will accelerate in network protection and advanced encryption.

Ubiquitous Computing and Wireless Networks: This research will ensure that mobile and wireless systems can be integral parts of the Internet. These inventions will permit devices embedded in equipment, vehicles, portable or wearable devices such as medical monitoring equipment, and even kitchen appliances to identify themselves to networks automatically and operate with appropriate levels of privacy and security.

Intelligent Machines and Networks of Robots: Fundamental research in robots will help revolutionize our work and our lives — from earthmoving devices in hazardous environments to devices that fit inside blood vessels and help operating room surgeons to simple household

robots. For example, NASA needs space probes that are smart, adaptable, curious, self-sufficient in unpredictable environments, and capable of operating in groups.

Future Generations of Computers: New paradigms will use advances in quantum computation and molecular and nano-electronics to devise radically faster computers to solve problems previously described as “uncomputable,” such as full-scale simulations of our biosphere or surgical simulations. Viewing cells as computational devices will help enable the design of next generation computers that feature self organization, self repair, and adaptive characteristics that we see in biological systems.

More Reliable Software: Software bugs and glitches continue to shut down airports, delay product shipment dates, and crash 911 emergency systems. Methods to design and test software need to be as productive and predictable as tools used to design and test aircraft and bridges.

Broadband Optical Networks: DOD researchers have shown that optical networking can provide 1,000 times faster network backbone speeds. Improvements in optical switching and development of all-optical end-user access technologies will let users take full advantage of these speeds.

Educate and Train a New Generation of Researchers: New investments will fund more researchers, who are critical to increasing both IT research and teaching, and support major research centers. Programs such as the teams to exploit advances in computing will provide opportunities to educate and train a new generation of researchers whose skills cross-disciplinary boundaries.

Large Scale Networking (LSN) R&D

The research priorities addressing network capabilities fall under the Large Scale Networking (LSN) R&D component of the coordinated, interagency IT R&D programs. Our ability to fully capture the future benefits of IT depends on learning how to build and use large, complex, highly-reliable and secure systems. The President’s FY2001 budget proposes \$334 million for LSN R&D, which includes:

the LSN base programs in traditional networking research to support agency mission requirements
the Next Generation Internet (NGI) initiative, and
research in Scalable Information Infrastructure (SII)

LSN base programs explore long range fundamental networking research issues and transition developing LSN products into tools to support agency missions. Continuing the Federally-supported R&D responsible for the core technologies that made the Internet and

Internet applications possible, LSN focuses on technologies needed by the Federal agencies, infrastructure to support agency networking, and networking applications development.

Since its inception in 1998, the Next Generation Internet (NGI) initiative has been a primary focus of LSN, building on the LSN base programs to provide the networking research, testbeds, and applications needed to assure the scalability, reliability, and services required by the Internet over the next decade. The program has provided fast network testbed connections to 170 universities and other facilities, exceeding program goals for connecting 100 sites. It is now focused on two goals: providing revolutionary networking capable of operation at speeds a thousand times faster than typical systems operating when the program began, and providing key functionality for high speed networks including reliability, scalability, security, an ability to multicast, an ability to gracefully accommodate mobile wireless users and other users that may enter and leave the system, and other requirements of complex modern networks.

Scalable Information Infrastructure (SII) is the newest component of LSN. It was developed in response to PITAC recommendations for an expanded Federal role in networking R&D that includes interoperability and usability. The SII research goal is to develop tools and techniques that enable the Internet to grow (scale) while transparently supporting user demands. An integral part of LSN, SII R&D complements the LSN and NGI efforts. SII research will focus on deeply networked systems: anytime, anywhere connectivity; and network modeling and simulation.

The President's FY 2001 budget request by agency for the LSN component of IT R&D is as follows:

Agency	FY 2001 (millions)
Department of Commerce	
National Institute of Standards & Technology	4.2
National Oceanic & Atmospheric Admin	2.7
Department of Defense	87.2
Department of Energy	32.0
Department of Health and Human Services	
Agency for Healthcare Research and Quality	7.4
National Institutes of Health	65.6
National Aeronautics and Space Admin	19.5
National Science Foundation	111.2

*numbers may not add due to rounding

Next Generation Internet 2000 Act

The Administration believes that the support for the LSN component of the coordinated, interagency IT R&D programs indicated in S.2046, the Next Generation Internet

(NGI) 2000 Act is an important first step towards meeting our national needs for IT research. Fast, reliable, ubiquitous networks provide the lifeblood for a 21st century economy. They are essential for the conduct of business providing tools that can tie even the smallest businesses into international production and sales networks and let businesses of all sizes speed the rate they develop, test, produce, and market goods and services worldwide. Modern information networks are becoming essential elements of education and training, critical for providing safe air and highway transportation, and central for strategies aimed at boosting national productivity while minimizing the impact of economic activity on the natural environment. Fast, flexible, easily reconfigured networks are essential tools for our nation's military at peace, at war, and in the multiple peacekeeping and other tasks they are asked to provide. This is clearly a vital element of our national IT research portfolio, and the Administration welcomes the Subcommittee's support in gaining funding for this important research.

We feel strongly, however, -that networking research must be conducted as an integral part of a program providing balanced investment in advanced software, high-end computing, high confidence systems, human-machine interface issues, and applications research which draw on innovations in both information science and research teams in areas such as advanced materials, climate and weather modeling, or astrophysics, as well as research into the social, legal, ethical and other issues raised by advances in information technology. This approach is consistent with the PITAC's directive to strengthen our Federal IT research programs by providing adequate funding for a complete and balanced IT research portfolio. -We commend the Subcommittee for acknowledging in Section 3(1) of the bill the importance of supporting other IT research carried out by our Federal IT R&D programs. The language of the bill indicates, somewhat confusingly, that these activities should be authorized through the Next Generation Internet Program and the Large Scale Networking Program. However, the other elements of the Federal IT R&D program are complementary to, not subordinate to, the networking research authorized by the bill.

Networking research must be tied closely to research on the computers, the software, and the applications that drive them. Many of the most intractable problems in network research involve management of networks which may connect millions or even billions of nodes, providing high security and privacy at low cost in dollars or communication speed, and building systems which do not fail catastrophically when faced with component failures or hostile intrusion. All of these areas require close collaboration with researchers working software, the next generation of computers, and other parts of the information technology research program supported in our budget.

The President's FY2001 IT R&D budget presents all IT research, along with networking research, in a balanced R&D portfolio, as recommended by the PITAC. We hope that the Senate will support authorization for the entire range of information technology research as proposed by the President's budget and in accord with the PITAC's recommendations.

We were pleased to see the Committee's interest in providing the resources of information technologies to minority -serving institutions, rural communities and other underserved areas and groups. As you know, the Administration is seriously concerned about the nation's digital divide and its impact on the ability of these institutions to participate in our research enterprise. However, we believe that the bill is too prescriptive in providing resources for research on infrastructure for rural, minority and small colleges. Programs such as EPSCOR and the Minority Institutions Infrastructure already provide mechanisms through which these issues can be addressed. Also, starting with its new FY 2000 funding for IT R&D, the NSF has called on proposers to explore linkages with other institutions including HBCUs, Hispanic institutions, EPSCOR states and others to broaden the participation in the program. This strategy is used in many other ITR&D programs and links traditionally strong majority institutions with the strengths at HBCUs. We are concerned that specific set-asides provided through the legislation may not be the most efficient and productive way to provide greater opportunities for these institutions. We would like to work with the Committee to ensure that existing programs are strengthened to permit ~~fuller~~ greater participation in Federally-funded IT research and access to IT R&D resources.

We note that section 7 of the bill directs the National Academy of Sciences to conduct a digital divide study. The Administration believes this requirement should be deleted from the bill because it duplicates efforts already underway at the Department of Commerce. Commerce's National Telecommunications and Information Administration published the first "digital divide" study in 1995. Its most recent study, "Falling Through the Net: Defining the Digital Divide" (July 1999), has become the leading source of critical information on Internet access and computer usage. The NTIA study uses data collected by Commerce's Bureau of Census. The President's 2001 budget includes funding to permit NTIA to make this an annual study.

Many of the funding levels authorized by S.2046, as introduced on February 9, are consistent with those proposed for the LSN R&D programs in the President's FY2001 budget. One exception is that the proposed legislation does not appear to authorize funding for the National Oceanic and Atmospheric Administration (NOAA). NOAA is a long-time participant in the Federal LSN programs, including the Global Ocean Interactive Network (GOIN) demonstration project in March 1999 which linked U.S. ocean researchers with partners in Japan. Using links supplied by NASA, DoD, and NSF, NOAA's Pacific Marine Environmental Laboratory (PMEL) demonstrated the first NOAA applications over the NGI, including Ocean Share, a collaborative environment for oceanographic research, and 3-D tools using VRML to demonstrate the evolution of El Niño, fisheries larval drift, and fur seal feeding trips. Further research will include exploring methods of using advanced networks for aggregating the vast quantities of data from NOAA's satellite and radar weather sensors and multicasting the data to the nation's research community for the development of improved weather forecasting, developing tools to enhance collaboration among atmospheric scientists

and oceanographers over the NGI, and increasing the robustness, security, and flexibility of networks for environmental research. We hope that the Subcommittee will modify its proposal to authorize funding for NOAA, as outlined in the President's budget.

Finally, although it received separate authorization in the NGI Act of 1998, the work on the Next Generation Internet initiative has always been an integral part of ongoing work in the Large Scale Networking component of the coordinated, interagency IT R&D program. This year, as noted above, LSN includes not only the base programs and NGI, but also expanded research in Scalable Information Infrastructure research. It appears that all of these elements, which are combined in the LSN R&D portion of the overall IT R&D program we plan to undertake, are authorized by S.2046. The Administration clearly prefers that the Committee take a more comprehensive approach to authorizing IT research. While the Committee takes this suggestion under advisement, we would urge -you to refer to the programs authorized by the current proposed legislation as Large Scale Networking, rather than by the name of one of the program subcomponents (NGI).

I hope that we can work with the committee to make these modifications and resolve any other issues during the weeks ahead.

Conclusion

We thank the Subcommittee for its continued support of these vital research programs, first through the NGI Act of 1998 and now with the proposed NGI 2000 Act. These investments are an essential part of a larger, balanced portfolio of research developed according to the PITAC's directives for adequately funding our Federal IT research programs. The strong bipartisan support generated by these and complementary proposals allow us to invest in America's future and ensure its continued prosperity. We hope that we can work with the Committee to support the entire IT research portfolio proposed by the President. We believe strongly that this program provides a balanced program of research essential to the nation's prosperity and its ability to secure public benefits ranging from national security to environmental protection. I look forward to working with the Committee on these issues in the weeks ahead.